Available online on 15.05.2024 at http://jddtonline.info

Journal of Drug Delivery and Therapeutics

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Research Article

# Soil-Transmitted Helminthiasis, Intestinal Schistosomiasis and Malaria Co-Infections among Children in Rural Communities Around Rwasave and Cyarwa Valleys

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## Article Info:

### Article History:

Received 12 March 2024
Reviewed 14 April 2024
Accepted 02 May 2024
Published 15 May 2024

### Cite this article as:

Jeannine U, Alain Prudence I, Leon M, Evariste N, Jean de Dieu T, Soil-Transmitted Helminthiasis, Intestinal Schistosomiasis and Malaria Co-Infections among Children in Rural Communities Around Rwasave and Cyarwa Valleys, Journal of Drug Delivery and Therapeutics. 2024; 14(5):103-107

*DOI: http://dx.doi.org/10.22270/jddt.v14i5.6613*

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## Abstract

**Background:** Soil-transmitted helminthiasis, schistosomiasis and malaria remain a threat in developing countries, especially to people living in rural areas near large water bodies, valleys or swamps whose daily life activities revolve around those areas. In addition, these parasites affect different groups of people especially those in contact with their breeding sites including children mostly due to their developing immunity compared to that of old people.

**Methodology:** This cross-sectional study was conducted in rural communities near the Rwasave and Cyarwa valleys, with 124 school-aged children participating. Stool samples were tested for the presence of STH eggs and intestinal Schistosoma parasites using the Kato Katz technique, and thick blood smears were made to aid in the identification of plasmodium species in blood. The threshold intensity of infection on STHs and Schistosoma sp. was estimated by counting their eggs microscopically, which aided in classifying infections as light, moderate, or heavy according to WHO standards. Furthermore, *Plasmodium species* were identified by the presence of schizonts, trophozoites, or gametocytes on Giemsa-stained thick blood smears, and parasitic density was calculated as a result.

**Results:** In this study, the highest prevalence of soil transmitted helminthiasis was 12.7% in Cyarwa valley compared to 12.5% in Rwasave valley. The highest prevalence of Schistosomiasis was 3.2% in Cyarwa valley compared to 1.3% in Rwasave valley. Prevalence of malaria in Cyarwa valley was 3.3% in 63 children. Where children infected were only males falling in 5-8 age group.

**Conclusion:** Results showed high prevalence of soil transmitted helminthiasis which was 12.7% in Cyarwa compared to 12.5% in Rwasave valley especially in children aged 5-8, this due to poor sanitation ($P<0.001$) that have assessed. Surprisingly, Cyarwa valley is located nearby town. Whereas malaria, intestinal schistosomiasis was low and there were not significantly associated with their risk factors with p-values 0.4, 0.092 respectively which can show that, preventive measures that have been established by government of Rwanda have positive impacts. Furthermore, there was a low prevalence of soil transmitted helminthiasis, intestinal schistosomiasis and malaria co-infection.

**Keywords:** soil transmitted helminthiasis, intestinal schistosomiasis, malaria.

## INTRODUCTION

Soil-transmitted helminthiasis, schistosomiasis and malaria remain a threat in developing countries, especially to people living in rural areas near large water bodies, valleys or swamps whose daily life activities revolve around those areas[1]. In addition, these parasites affect different groups of people especially those in contact with their breeding sites including children mostly due to their developing immunity compared to that of old people[2].

Soil-transmitted helminths pose serious public health challenges worldwide, affecting more than 1.75 billion people, with 471 million, 477 million and 804 million infected with hookworms, *Trichuris trichiura* and *Ascaris lumbricoides* respectively[2]. Preschool and school-going children carry the highest burden with data showing that above 270 million preschool children and above 600 million school-going children are infected[2]. In Rwanda, A national survey conducted in 2008 showed that over 8000 school children and 66% of children were infected with soil-transmitted helminths[3].

Schistosomiasis is one of the neglected tropical diseases caused by Schistosoma species[4]. Worldwide schistosomiasis causes morbidity among people with an estimated 230 million and 200,000 deaths occurring annually[2].In Rwanda, a survey done among 270 school-aged children and adults showed a schistosomiasis prevalence of 20.1%[3]. Generally, these findings highlight the high prevalence of *Schistosoma mansoni* transmission in Rwanda and the prevalence of the infection varies from one epidemiological setting to another[3].

Malaria is a life-threatening disease caused by plasmodium species and it is transmitted via an infected female anopheles mosquito bite[5]. Reports from WHO indicated 241 million cases of malaria in 2020 with children under five years old accounting for almost 80% of all malaria deaths[6]. In Rwanda, a study conducted by Rudasingwa & Cho[7], in 2020 showed that 7.4 % of 3180 children were infected. However, there was a reduction in incidence from 400 to 148 per 1000 in 2020[8].

Soil-transmitted helminthiasis and schistosomiasis are classified into a group of neglected tropical diseases[2]. These parasites have shown co-infection with a prevalence of 6% in 2020 by Jean Claude et. Al[9] in school-aged children. However, the literature related to this co-infection in Rwanda remain uncommon. Although schistosomiasis and malaria co-infection, are believed to be the major parasitic diseases of the tropics causing morbidity and mortality out of the 825 infected children[1], different studies in Rwanda reported the prevalence of different parasites and their burden on the country but there is limited data on the prevalence of co-infections.

Soil-transmitted helminths and malaria co-infection prevalence are estimated high in children living in endemic countries[1,10] and an overall prevalence of plasmodium-helminths co-infections reported was 17.7%[10]. In Rwanda, a study conducted by Marcelline et.al in 2016 reported that the overall prevalence of malaria, helminthiasis and anaemia was 30.8%, 47.5% and 30.1% respectively, with helminthiasis estimated to be more prevalent among 6- to 10-year-old children and its co-infection with malaria was 61.5%[5].

Schistosomiasis, soil-transmitted helminthiasis, and malaria are reported to be triple threats in preschool and school-going children[1]. A study conducted in 2010 determined the prevalence of *Plasmodium falciparum*-malaria, intestinal schistosomiasis, soil-transmitted helminth infections, and their respective co-infections among school-going children and found that the prevalence of co-infection of *Plasmodium falciparum*, *Schistosoma mansoni* and hookworm was 2.8%[11]. In Rwanda, there is limited availability of data on the prevalence of polyparasitism especially those which are classified as neglected tropical diseases.

Generally, Helminthiasis, Schistosomiasis and malaria affect poor people living in rural and peri-urban settings with limited access to clean water, and inadequate sanitation and hygiene services[1]. In addition, people living near irrigation sites, dam areas, those who rear livestock near rivers, and also those who don't use mosquito nets during the night, are at high risk of being infected with malaria[12]. The present study, therefore, was aimed to determine the prevalence of soil-transmitted helminths, Schistosoma, and Malaria co-infections among 5-12 years old children living around the Rwasave and Cyarwa valleys of the southern province of Rwanda. Furthermore, understanding the degree of polyparasitism in high-risk groups will aid in the development of effective intervention measures to minimize disease burden and co-morbidity.

## METHODOLOGY

### Study area

The present study was conducted in rural communities living around Rwasave and Cyarwa valleys.

### Study Design

A cross-sectional study design was used in this study to determine the prevalence of soil-transmitted helminths, Schistosoma, and Malaria co-infections among 5-12 years old children living around the Rwasave and Cyarwa valleys of the southern province of Rwanda.

### Study Population

The current study involved participants aged 5-12 years lived in rural communities near Rwasave and Cyarwa valleys.

### Sampling technique

A convenient sampling strategy was used in this study. This non-probability sampling technique included all participants aged 5-12 years old available and willing to participate during the time of the study until the sample size was achieved.

### Data collection methods and procedures

A structured questionnaire was used for the collection of socio-demographic information and possible risk factors associated with the infections including poor sanitation, access to clean water, wearing shoes, and the use of bed nets. To diagnose STHs and Schistosoma infections in stool specimens, children's parents or their guardians were given labelled plastic stool containers and instructions by a research team on how to collect a portion of their morning stool samples a day before the parasitological screening. Then, stool samples were collected by a member of the research team the following day and brought to Rango Health Center Laboratory for analysis. A direct wet mount stool examination was performed immediately by emulsifying a small portion of the stool sample with normal saline for microscopic examination using light microscopy. In addition, a Kato-Katz cellophane thick smear was made from each sample and examined immediately to avoid the disappearance of the helminthic eggs due to deterioration. To determine the threshold intensity of infection, the mean number of eggs counted per gram of faeces, from each Kato Katz thick smear was multiplied by 50 because a Kato Katz template of 20 mg was used. Following the WHO standard procedure, infection intensity was classified as light, moderate, or heavy for common STHs infections[13]. Laboratory procedures were carried out following standard operating procedures. Stool samples were chosen at random for quality control and examined by a third person who was not aware of the previous test results.

For malaria diagnosis, a finger pricks blood sample was collected after cleaning the finger surface using an alcohol swab (70% isopropanol-impregnated swabs) on the same day of collecting stool specimens. One thick smear was produced and stained with a newly prepared 10% Giemsa working solution (prepared after filtration of stock solution) in phosphate-buffered water (pH 7.2). Parasite density was estimated under a light microscope at high magnification by counting the number of parasites per 200 white blood cells (WBC). If < 100 parasites were found, the reading continued up to 500 WBC[14]. The determination of a *plasmodium species* is made with certainty by the presence of trophozoites, schizonts or gametocytes. However, no speciation was done as this study emphasized only the presence or absence of *plasmodium species* and parasitic density. The following formula was used to calculate parasite density:

$$\text{Parasitaemia} = \frac{\#parasite\ counted * 8000}{\#WBC\ counted (200\ or\ 500)}$$ where 8000, a multiplication factor.

### Data analysis

After verifying the structured questionnaire completeness, data were entered into a Microsoft Excel database, version 2016 (16.0.4266.1001 version) and then, the data collected were imported into SPSS analyzing tool version 22.0.0.0 for statistical analysis to calculate percentages, and descriptive statistics (i.e. mean, standard deviation, etc.) and to design tables. The prevalences were expressed in all sites and were stratified by gender and age bands of 5-8 and 9-12 years. The P-value was calculated to determine the correlation between parasites and socio-demographic variables and a P-value of <0.05 was considered statistically significant in all comparisons. Chi-squared ($X^2$) tests were used to assess the association of variables such as mixed infections (single and double or triple parasitic infections) with demographics. The t-test was used to compare the mean difference in STHs, *Schistosoma* infection intensity and *plasmodium* sp. density between the Cyarwa and Rwasave valleys. results were presented using tables, charts and graphs.

## RESULTS

### Participants information

This study enrolled 143 children of which 76 (53.1%) were males and 67 (46.9%) were females. Among them, 80(55.9%) children were from rural communities near the Rwasave valley and 63 (44.1%) lived near Cyarwa valley. Study participants were aged 5 to 12 years old, with a mean age of 8.13 (n=143, SD=2.31) years and were all born or lived near those valleys which they recruited from more than six months.

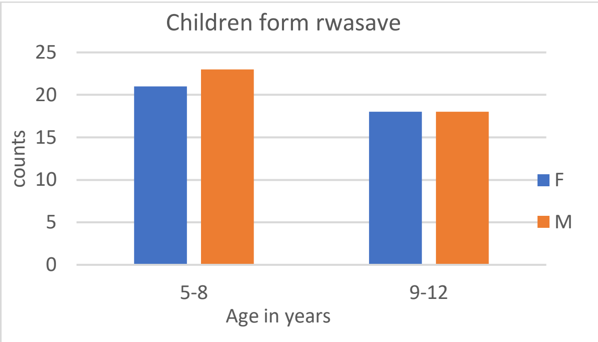


Figure. 4.1. children from regions around rwasave

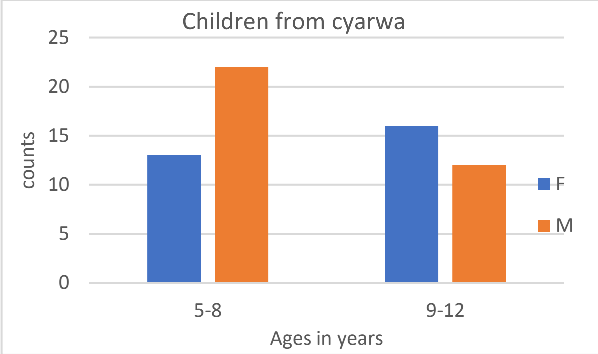


Figure.4.2. children from cyarwa

### Prevalence of soil-transmitted helminths, intestinal schistosomiasis, malaria parasite and their coinfections.

This study reported a high prevalence of single or mixed infection of soil-transmitted helminths in communities near Rwasave valley with 12.5% (n=11, 95%CI: 0.0621-0.2129), whereas intestinal schistosomiasis, and malaria infection were 1.3% (n=1, 95%CI:-0.0118-0.0368), and 0%(95%CI:0) in school-aged children respectively. Contrarily, the community around Cyarwa had a prevalence of 12.7%(n=7, 95%CI: 0.107-0.113) for single or mixed infection of STHs, 3.2%(n=2, 95%CI:-0.01142-0.07482) for intestinal schistosomiasis, and 3.3%(n=2, 95%CI: 0.012-0.072) for malaria infection. In addition, the low prevalence of double co-infection was observed primarily in communities near Cyarwa, with 1.6%(n=1, 95%CI: -0.015-0.045) of both STHs-Malaria and Schistosomiasis-malaria co-infections recorded. However, STHs & Schistosomiasis, on the other hand, did not co-infect. Furthermore, none of the participants were infected with all three infections. On the other hand, only 1.3%(n=1, 95%CI: -0.0118-0.0368) of communities near Rwasave had of co-infection with STHs and Schistosomiasis, and also no co-infection with all three infections recorded.

-and as(See table 4.1.).

Table 4.1. shows Prevalence of soil transmitted helminths, intestinal schistosomiasis, malaria and their co-infections.

| Prevalence of single and multiple infections | | | | | | |
|---|---|---|---|---|---|---|
| | RWASAVE (N=80) | | | CYARWA (N= 63) | | |
| | Prevalence | | | Prevalence | | |
| **Single infection** | n | (%) | 95% C.I | n | (%) | 95% C.I |
| Malaria | 0 | 0% | 0-0 | 2 | 3.3% | 0.012-0.072 |
| STHs | 11 | 12.5% | 0.0621-0.2129 | 7 | 12.7% | 0.107-0.113 |
| Intestinal schistosoma sp | 1 | 1.3% | -0.0118-0.0368 | 2 | 3.2% | -0.01142-0.07482 |
| **Co-infections** | | | | | | |
| Malaria and STHs | 0 | 0% | 0-0 | 1 | 1.6% | -0.015-0.045 |
| Malaria and intestinal schistosoma sp | 0 | 0% | 0-0 | 1 | 1.6% | -0.015-0.045 |
| STHs and intestinal schistosoma sp | 1 | 1.3% | -0.0118-0.0368 | 0 | 0% | 0-0 |
| intestinal schistosoma sp and STHs and Malaria | 0 | 0% | 0-0 | 0 | 0% | 0-0 |

**Risk factors associated with soil-transmitted helminths, intestinal schistosomiasis, plasmodium parasites and their coinfections.**

School-aged children who did not practice washing their hands before eating, walking barefoot, or fetching water in the valley had the highest likelihood of becoming infected with soil-transmitted helminths, with an odd ratio of 14 (P=0.0001). However, those factors were insignificant in children to get infected with Intestinal schistosomiasis (n=3, p<0.092). Also, not sleeping under mosquito nets was not a significant factor to get malaria infection (n=2, p=0.4) in children near both Rwasave and Cyarwa valleys. The occurrence of co-infection (n=1, p=0.067) of STHs and Malaria as well as STHs-Schistosomiasis and Schistosomiasis-Malaria recorded in children walking barefoot, fetching in the valley, hand washing and not sleeping under mosquito-nets were statistically insignificant However, no risk factor associated with co-infection with all three infections because there was no case recorded (Table. 4.2).

Table 4.2. Risk factors associated soil transmitted helminths, intestinal schistosomiasis, plasmodium parasites and their coinfections.

| Characteristics of participants | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| risk factors | overall(n=143) | STH (n=18) | P Value | Intestinal schistosomiasis (n=3) | P Value | MALARIA (n=2) | P Value | STH and Malaria | P Value | STH and Schistosomiasis | P VALUE | Schistosomiasis and Malaria | P VALUE |
| | (n,(%)) | (n,(%) | | | | | | | | | | | |
| Hand-washing | | | | | | | | | | | | | |
| yes | 88 (61.5%) | 2 (2.3%) | | 2 (2.3%) | 0.092 | 2 (2.3%) | | 0 (0%) | | | | | |
| no | 55 (38.5%) | 16 (29.1%) | <0.001 | 1 (1.8%) | | 0 (0%) | | 1 (1.8%) | 0.067 | 1 | 1 | 1 | 0.067 |
| Wearing-shoes always | | | | | | | | | | | | | |
| yes | 58 (40.6%) | 4 (6.9%) | | 0 (0%) | | 1 (1.7%) | | 0 (0) | | | | | |
| no | 85 (59.4%) | 14 (16.5%) | <0.001 | 3 (3.5%) | 0.092 | 1 (1.2%) | | 1 (1.2%) | 0.067 | 1 | 1 | 1 | 0.067 |
| Mosquito -nets | | | | | | | | | | | | | |
| yes | 79 (55.2%) | 17 (21.5%) | <0.001 | 2 (2.5%) | | 0 (0%) | | 0 (0%) | | | | | |
| no | 64 (44.8%) | 1 (1.6%) | | 1 (1.5%) | | 2 (3.1%) | 0.4 | 1 (1.5%) | 0.067 | 1 | 1 | 1 | 0.067 |
| Fetching valley water | | | | | | | | | | | | | |
| yes | 139 (97.2%) | 18 (12.9%) | <0.001 | 2 (1.4%) | | 1 (0.7%) | | 1 (0.7%) | 0.067 | 1 | 1 | 1 | 0.067 |
| no | 4 (2.8%) | 0 (0%) | | 1 (25%) | | 1 (25%) | | | | | | | |

key: p value is significantly considered when is less than 0.05 hence based on the above table STH was significantly associated with risk factors of handwashing factor where among 18 children infected 16 were not able to wash their hands after using latrines. confidence level (95%)

**The intensity of soil-transmitted helminths, intestinal schistosomiasis and Plasmodium species.**

The overall mean intensity of soil-transmitted helminthiasis recorded was 457.5 eggs/gramof faeces with the highest mean intensity of 495 eggs/gram of faeces in school aged children near Rwasave and the lowest mean intensity of 420 eggs/gram seen in Cyarwa. Schistosomiasis mean intensity for Rwasave and Cyarwa were 150 eggs/gram and 200 eggs/gram respectively with an overall intensity of 166.7 eggs/gram. However, the overall mean parasite density for malaria was 420 parasites/µl of blood.

Table 4.3. The intensity of soil-transmitted helminths, intestinal schistosomiasis and Plasmodium species.

| Variables | Infection status | Cyarwa | Rwasave | P value |
|---|---|---|---|---|
| STHs (Mean) | Light | 8 | 10 | 0.962 |
| | Moderate | 0 | 0 | |
| | Heavy | 0 | 0 | |
| Schistosomiasis | Light | 0 | 0 | 0.962 |
| | Moderate | 2 | 1 | |
| | Heavy | 0 | 0 | |
| Plasmodium | Low | 2 | 0 | |
| | High | 0 | 0 | |

Key: According to WHO[13] soil-transmitted helminth infection is considered light, moderate and heavy when they are (1-4999, 5000-49999,>50,000) eggs/gram respectively. Schistosomiasis is considered a light, moderate and heavy infection when they are (1-99,100-399, >400) eggs/gram respectively. For plasmodium the intensity(55) is measured in parasites/ µl and classified based on <1000, 1000-4999, 5000-99999, >100000 when they are low, moderate, high and hyper-parasitemia respectively. P value significant at 0.01. confidence level (95%)

## DISCUSSION

In this study, the highest prevalence of soil transmitted helminthiasis was 12.7% in Cyarwa valley compared to 12.5% in Rwasave valley. This infection was mainly found in males falling in 5-8 age group and this high number could be explained by the factor that males they are the one who mostly go to the valleys compared to female as it was found to be 73, 65 male and female respectively. This is similar to those shown that pre-school and school-aged children carry the highest prevalence of soil transmitted helminths[4]. And also, this infection was mainly found in children who didn't prefer to wash their hands after using toilets (p <0.001) (See table 4.2). which is also similar to factors shown that those parasites are also spread in areas with poor sanitation[15].

The highest prevalence of Schistosomiasis was 3.2% in Cyarwa valley compared to 1.3% in Rwasave valley. Both prevalence's were low compared to 20.1% that have found among 240 children [16]. This discrepancy could be due to different age groups that were used. This infection was found in males and female falling in both age groups 5-8 & 9-12. Also, schistosomiasis has been found in children who are exposed to valley, fetching valley's water and those who likely went to the valley with bare feet (P=0.092) (See table 4.2). these factors are similar to those shown [4] that when your skin is in contact with contaminated freshwater, you are risky of being infected.

Prevalence of malaria in Cyarwa valley was 3.3% in 63 children. Where children infected were only males falling in 5-8 age group. Surprisingly, this prevalence was high compared to 7.4 % of 3180 children found in 2020[7] . This discrepancy could be due different study area, and age-group. Moreover, malaria infection was found in children who didn't sleep under mosquito nets which is one of risk factors associated with malaria infection (P=0.4) (See table 4.2). Prevalence of malaria and soil transmitted helminthiasis was observed in Cyarwa valley which is 1.6% of 63 children. Where children infected were only males falling in 5-8 age group. This prevalence is low compared to 61.5% in 465 children from Bugesera district have shown [5] . This difference could be due to different study areas and age-groups.

Prevalence of malaria and schistosomiasis was observed in Cyarwa valley which is 1.6% of 63 children. Where children infected were only males falling in 5-8 age group. This prevalence is low compared to 26.3% of 825 children that have shown [11]. This difference could be due to different study areas, age-groups and sample size.

prevalence of soil transmitted helminthiasis and schistosomiasis was observed in Rwasave valley which is 1.3%. Children infected were only males falling in 5-8 age group This prevalence is low compared to 4.76% [9]. This could be due to different study areas, age-groups and sample size. This study suggested negative co-infection between soil transmitted helminthiasis, intestinal schistosomiasis and malaria

## CONCLUSION

Results showed high prevalence of soil transmitted helminthiasis which was 12.7% in Cyarwa compared to 12.5% in Rwasave valley especially in children aged 5-8, this due to poor sanitation (P<0.001) that have assessed. Surprisingly, Cyarwa valley is located nearby town. Whereas malaria, intestinal schistosomiasis was low and there were not significantly associated with their risk factors with p-values 0.4, 0.092 respectively which can show that, preventive measures that have been established by government of Rwanda have positive impacts. Furthermore, there was a low prevalence of soil transmitted helminthiasis, intestinal schistosomiasis and malaria co-infection.

## Acknowledgments

We extend our gratitude to the University of Rwanda, Rango Health Center and Kabutare District Hospital for facilitating this study at their health facilities.

## Conflict of interest

Authors declare no conflict of interest

## Availability of raw data and material

Raw data and information on material should be obtained from the corresponding author upon request.

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